THE DISTRIBUTION AND ECOLOGY OF MARINE BIRDS OVER THE CONTINENTAL SHELF OF ARGENTINA IN WINTER

JOSEPH R. JEHL, JR.

ABSTRACT.—Quantitative data on the distribution and abundance of marine birds in winter were obtained on three transects of the coastal shelf of Argentina in 1971 and 1972. On the basis of avifaunal assemblages, the shelf waters can be divided into two zones, the boundary occurring near the southern edge of Golfo San Jorge (47°S). *Spheniscus magellanicus*, *Puffinus griseus*, and *Sterna hirundinacea* were characteristic of the northern zone; *Fulmarus glacialoides*, *Eudyptes crestatus*, *Pelecanoides magellani*, *Diomedea exulans/epomophora*, and *Pachyptila* sp. of the southern zone. Beyond the continental shelf off northern Argentina the avifauna was similar to that over the southern shelf, but included several additional species: *Garroidia nereis*, *Procellaria cinereus*, and *Pelecanoides urinatrix*.

Winter sea bird populations along the coast of Argentina appear to be established by mid-June and to remain stable through the winter. In general, abundances seemed low and concentrations were found mainly in areas of strong mixing or upwelling. The winter census data are compared with those from a brief summer transect. Despite pronounced shifts in the ranges of individual species, there was little seasonal difference in total sea bird abundance. A preliminary ecological study indicated that the bulk of the sea bird biomass through the entire year is contributed by large species that obtain their food from the upper meter of the sea, mainly by surface seizing. However, marked seasonal and latitudinal differences in patterns of resource utilization appear among divers, plungers, and filter feeders.

Circumstantial evidence suggests that oil pollution is a major cause of sea bird mortality, particularly over the northern shelf.

Although sea birds are among the most conspicuous inhabitants of the ocean, their role in marine ecosystems has received little attention (Ashmole, 1971). Basic information such as population sizes at different seasons, species composition of sea bird flocks, and periods of migration are prerequisites for ecological analysis. While such data are slowly beginning to accumulate (e.g., King, 1970), they are inadequate if not entirely lacking for most parts of the world.

In the austral winters of 1971 and 1972, the R/V Hero, a research vessel of the National Science Foundation was engaged in oceanographic research along the coast of Argentina (Cummings et al., 1971; Jehl, 1973b). One objective was to obtain data on the distribution, abundance, and ecology of sea birds over the continental shelf. General patterns of sea bird distribution in this area have been presented by Murphy (1936), Escalante (1970), and others (references in Cooke and Mills, 1972). Watson et al. (1971) have mapped the distribution of those antarctic and subantarctic species that occur there. Yet, detailed data are scarce and pertain mostly to observations made in spring, summer, or autumn. With the exception of Cooke and Mills' (1972) report on a brief summer transect between Buenos Aires and Tierra del Fuego there seem to be no precise quantitative data for shelf waters at any season. Tickell and Woods (1972) discussed sea bird abundance between Montevideo, Uruguay, and the Falkland Islands on the basis of 17 transects in the period November-May 1954-64; however, their transect route was largely beyond the continental shelf and their quantitative data are too simplified for detailed analysis.

This paper deals mainly with quantitative data obtained on three transects of the Argentine coastal shelf: one in June 1971 between the Strait of Magellan and Bahía Blanca; the second in July 1971 on the return voyage; and the third in July-August 1972 between Buenos Aires and the Strait of Magellan. The dates of the several transect periods were far enough apart that distributional changes through the austral winter could be determined. The present data with those of Cooke and Mills (1972) also allow a preliminary comparison of summer and winter differences in abundance, distribution, and ecological impact of the sea bird fauna.

The survey area.—The coast of Argentina is bordered by a broad, shallow continental shelf, which extends offshore for about 180 km at the latitude of Mar del Plata, 500 km near Bahía Blanca, and 800 km, to the Falkland Islands, off the Strait of Magellan. Over most of the shelf depths are less than 60 fathoms, and along the transect routes depths over 40 fathoms were uncommon.

The shelf waters are derived from the subantarctic waters of the Falkland (Malvinas) Current, which flows northward along the edge of the continental slope. They can be separated into two zones. South of Golfo San Jorge (ca. 47° S) strong westerly winds prevail for most of the year, forcing surface waters seaward, and causing upwelling. In that area surface waters are cold and rich in dissolved oxygen, nitrates, and phosphates. North of Golfo San Jorge, surface waters are warmer and levels of dissolved nutrients are much lower. Beyond the continental shelf off northern Argentina, the Falkland Current brings subantarctic waters into sharp juxtaposition with the warmer shelf water. Although conditions there are similar to those prevailing over the southern shelf, it is useful to recognize a third zone beginning about 30 km landward of the continental slope.

The northern terminus of the Falkland Current varies seasonally. In August-September waters beyond the continental slope retain a subantarctic character to about 36°30' S. There they meet and mix with warmer waters moving northeastward off the continental shelf and with subtropical waters of the southward-flowing Brazil Current. This area of confluence, which is often realized near the mouth of the Rio de la Plata, creates rich feeding conditions for a wide variety of sea birds (Murphy, 1936; Escalante, 1970; Cooke and Mills, 1972). There is a pronounced faunal shift there, with warm water species reaching their southern limits and cold water species their northern limits over the shelf.

Detailed oceanographic information on the region may be obtained in the extensive series of "Pesqueria" reports (Aragno, 1968; Valdez, 1969; Villanueva, 1969-1971). Cooke and Mills have summarized some of these data that pertain to the summer months.

CRUISE TRACKS AND METHODS

In 1971 the Hero departed Punta Arenas, Chile, on 11 June and proceeded northward over the continental shelf of Argentina to Bahía Blanca, arriving on 25 June (Fig. 1). In general the transect route lay 16 to 40 km offshore, although we cruised within several km of the beach in Golfo San Jorge and Golfo Nuevo. Observations were made in Golfo San José on 22 and 23 June. We left Bahía Blanca on 28 June for Golfo San José, remaining inside the gulf until 8 July. After a port call in Puerto Madryn we proceeded southward on 12 July along a route similar to that of the northward transect, except for crossing Golfo San Jorge near its mouth. The cruise terminated in Punta Arenas on 16 July.

In 1972 the Hero left Buenos Aires, Argentina, on 26 July. Between 28 and 30 July we cruised slowly southwestward between 37°07' S and 41°40' S, mostly over deep water beyond the continental shelf but occasionally zigzagging over the edge of the shelf. Late on 30 July we re-entered shelf waters and headed to Puerto Madryn, arriving on 1 August. Late on 3 August we departed for Golfo San José, where we spent the period 4 to 19 August. Following a port call in Bahía Blanca, we departed for Punta Arenas on 22 August, arriving there on 30 August. The route was similar to that of the southward transect in 1971, except that most of 25 August was spent in Bahía Concepción and 27 August in Bahía de los Nodales.

In 1971 I made censuses as often as possible, except when the ship was at anchor. The duration of the observations depended upon weather conditions and ship's activities, and varied from 2 to 7 hours per day. In 1972, with the assistance of Jon P. Winter, it was possible to monitor bird populations almost continously. Most observations were made from a flying bridge 7 m above the waterline, affording good visibility in all directions. All birds were counted, but for ship-following species the maximum numbers were estimated hourly. In 1971, daily counts were totalled, whereas in 1972, for increased precision, they were divided into morning and afternoon components. Surface water temperatures were taken regularly except when sea conditions precluded work on deck. Quantitative data,

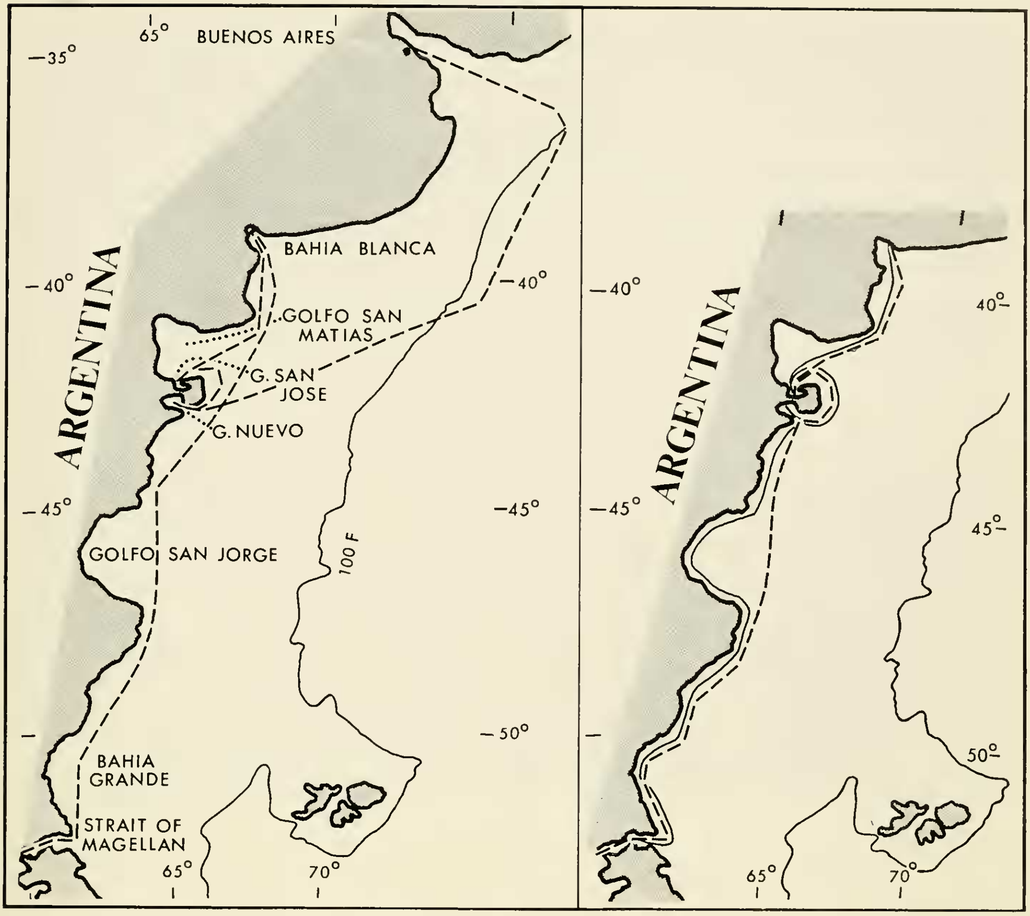

Figure 1. Cruise track of the R/V Hero along the coast of Argentina during transects reported in this study: 1972 (left), 1971 (right).

precise localities, and sea surface temperatures are given in Tables 1 and 2.

In this paper I consider only those species that regularly occur over the open ocean, or more than about 5 km from shore. Information on Golfo San José is presented elsewhere (Jehl, Rumboll, and Winter, 1973). Specimens obtained in these studies are deposited in the Natural History Museum, San Diego.

In the following species accounts I follow the generic classification of Procellariiformes of Alexander et al. (1965). Otherwise, classification and common names largely follow Meyer de Schauensee (1966). The exceptions involve my strong preference for retaining the traditional whalers' names for certain species. In my opinion the use of such prosaic names as Gray Petrel for Pediunker and White-chinned Petrel for Shoemaker has little, if anything, to recommend it.

ANNOTATED LIST OF SPECIES

Rockhopper Penguin (*Eudyptes crestatus*).—Rockhopper Penguins follow the Falkland Current north to Uruguay in winter (Escalante, 1970). They seem restricted to the cold, deep waters beyond the continental shelf, and may be much commoner off northern Argentina than the literature suggests. Groups of up to 15, mostly adults, were common between 36-40° S in late July 1972; the maximum concentration was 79/hour. Over the continental shelf, however, Rockhoppers were rare or absent. The only sighting in 1971 was of a single bird near 40° S on 15 July. In 1972 a few appeared at the southern edge of Golfo San Jorge, where surface temperatures dropped sharply to 4.4° C, but none were seen in colder waters farther south. In summer Cooke and Mills (1972) recorded only one Rockhopper over the shelf near 52°40'S.

Magellanic Penguin (*Spheniscus magellanicus*).—In summer Magellanic Penguins are common in the vicinity of nesting colonies in southern Argentina (i.e., south of 44° S); in winter they largely abandon these areas and move northward as far as Uruguay and southern Brazil. We found them fairly common between Buenos Aires and the Valdes Peninsula, uncommon to rare southward; in all areas their local abundance was markedly reduced by turbid water. All sightings were made in shelf waters, mostly within 30 km of shore in areas where surface temperatures exceeded 9° C. On all three transects we found concentrations 15 km off the Valdes Peninsula; maximum densities were 27/hour. The largest concentration, 300 birds, 150 km east of the peninsula on 31 July 1972, was near the area where Cooke and Mills found large flocks in summer. Penguin flocks were usually accompanied by South American Terns (*Sterna hirundinacea*) and Sooty Shearwaters (*Puffinus griseus*), which feed on fish that penguins drive to the surface. This penguin-tern-shearwater assemblage is the most conspicuous and characteristic avian grouping over northern shelf waters.

Wandering Albatross (*Diomedea exulans*), Royal Albatross (*D. epomophora*).—Rare over the northern shelf but slightly commoner farther south. In 1971 we saw occasional great albatrosses as far north as the Valdes Peninsula but the only concentration, 20 birds, was in Bahía Grande on 15 July. Small numbers near the Valdes Peninsula and in Golfo San Matías in late August 1972 indicate a northward shift of the population later in winter. Beyond the continental shelf great albatrosses were fairly common from 36-40° S. They appeared as soon as the ship crossed into deep water and often outnumbered the Black-brows. Their abundance declined immediately as we re-entered the shelf waters and en route to Puerto Madryn none was seen closer to land than 200 km.

On 29 July 1972 we saw over 110 great albatrosses, 3 of which were color banded; 30 were with a large flock of Black-brows at 39°22' S; 50 more along with other seabirds fed on scraps from a fishing trawler; and another 30 were scattered along the route. Most of the birds in the first group of 30 were photographed; of these, at least 4 were Royals (dark line on tomium visible) and 20 were Wanderers. Sight records suggest a similar species composition in the other groups. No Royals were identified over shelf waters in 1972, although two birds in 1971 were thought to be *epomophora* (Cabo Danoso, 15 July; Bahía Engano, 18 June).

Robertson and Kinsky (1972) showed that large numbers of Royal Albatrosses use the southwestern Atlantic as a major feeding area, particularly in winter. However, their suggestion (following Dabbene, *in* Murphy, 1936) that it is the common species of great albatross there is questionable. The present data indicate that Wanderers greatly outnumber Royals throughout the winter, in coastal as well as offshore waters. Robertson and Kinsky (1972) also found that about 55 per cent of the Royals wintering in the southwestern Atlantic are three years old or less and about 70 per cent are four or less. Wandering Albatrosses of those ages retain considerable brown in their plumage and should be distinguishable in the field (see Tickell, 1968: fig. 12). Yet, only one of over 145 great albatrosses observed in this study was in the brown juvenile plumage of *exulans*; four were in the adult "*chionoptera*" stage of *exulans*; and the rest were in plumages in which the two species are usually indistinguishable. If my estimates of relative abundance are accurate, it would appear that Wanderers wintering off Argentina average several years older than Royals in the same are. This is a potentially important biological difference between these similar species that requires confirmation. Furthermore, since mottled immatures of *exulans* were fairly common along the coast of Chile in the winter of 1970 (pers. obs.), the average age of Argentine Wanderers may be greater than that of birds wintering off the Pacific coast of South America.

Black-browed Albatross (*Diomedea melanophris*).—Common to abundant along the entire coast, except where waters are excessively turbid. In both years it was rather regularly distributed over the shelf north to Bahía Blanca, and concentrations were found off the Valdes Peninsula and in Golfo San Jorge, although in 1971 the largest numbers (150/hour) were seen in Bahía Grande. No important seasonal or yearly differences in

Figure 2. Part of a flock of 10,000 Black-browed Albatrosses and other sea birds. Coast of Argentina, 39°22'S, 55°22'W, 29 July 1972.

distribution were evident. Tickell and Woods (1972) did not observe seasonal differences in abundance on transects between Montevideo and the Falkland Islands.

The species was also common — and once spectacularly abundant — near the edge of the continental shelf. On the morning of 29 July 1972 an estimated 10,000 were feeding with other sea birds and a large pod of Pilot Whales (*Globicephala melaena*) near 39°22' S, 55°22' W at the edge of the shelf (Fig. 2). That afternoon an additional 10,000 were feeding on scraps from a large trawler. Over the entire route it appeared that adults outnumbered immatures by about 5 to 1, although immatures seemed more likely to occur in near-shore waters and mouths of bays. Many birds near Buenos Aires were heavily oiled.

Giant Petrel (*Macronectes giganteus*).—Widespread and remarkably uniformly distributed in shelf and offshore waters through the year, though commoner in winter. Usually three or four followed in our wake. Over 500 were scavenging offal near a fishing ship at 39°40' S on 29 July 1972.

In 1971 approximately 70 per cent of the birds seen were immatures, whereas in 1972 adults slightly outnumbered immatures over the continental shelf. This age distribution suggests a possible influx of adults later in the winter. Beyond the continental shelf immatures composed over 70 per cent of the flocks, and in harbors and waters very close to shore they predominated strongly. Only 3 white-phased birds were encountered, one with a huge flock of sea birds at 39°22' S in 1972, and two well inside Golfo Nuevo in 1971. No birds suspected of being *Macronectes halli* were among the giant petrels flying near the ship (see Bourne and Warham, 1966, for characters that may allow these similar species to be identified under field conditions).

Southern Fulmar (*Fulmarus glacialoides*).—Common to abundant over southern shelf waters in winter, in waters colder than 7° C. In June and July 1971, Southern Fulmars were common to about 49° S, but disappeared abruptly in warmer waters to the north. On the southward transect in August 1972 a few appeared at 44° S, where temperatures dropped under 7° C, but none was seen again until 47°24' (4.4° C). Fulmars were uncommon but regular beyond the continental shelf at 36-40° S; surface temperatures there were less than 6.7° C. Cooke and Mills did not record this species on their summer transect.

Cape Pigeon (*Daption capense*).— Cooke and Mills did not observe this species during their cruise. In June 1971 it was widely distributed but uncommon; in July 1971 it was seemingly commoner, especially in the south; and in August 1972 it was common over much of the shelf and in offshore waters. These data suggest a shift northward as the winter progresses. It occurred in greatest abundance beyond the continental shelf on 29 July 1972, where flocks of 4000 and 6000 were in association with albatross flocks.

Whale-birds or Prions (*Pachyptila* spp.).— In 1971 scattered prion flocks were seen between San Julián and the Valdes Peninsula, and in Golfo San José. The largest concentration (up to 150/hr.) occurred off Río Chico on 15 July. In August 1972 they were uncommon to rare over shelf waters, except inside Golfo San José (Jehl et al., 1973). Prions were somewhat commoner offshore, especially near 41°40' S, where we found scattered flocks of 10-15 birds. Although *P. desolata* and *P. belcheri* are said to occur in this general area (Escalante, 1970), the only specimens we obtained were *belcheri* (♂, 109 g, 37°22' S, 54°24' W; ♂, 41°38' S, 56°43" W; ♀?, Golfo San José). In summer Cooke and Mills observed prions only south of 50° S, near presumed breeding grounds.

Pediunker (*Procellaria cinereus*).— A single bird made several passes near the ship on 30 July 1972, when we set out a chum slick well offshore. This was our only observation of the species, which appears to avoid shelf waters at all seasons. Not recorded by Cooke and Mills.

Shoemaker (*Procellaria aequinoctialis*).— In June 1971, Shoemakers were widespread though generally uncommon along the entire coast, whereas a month later they were virtually absent south of 43° S. In August 1972, too, they were uncommon in coastal waters north of 44° S. and much rarer to the south. In both years concentrations occurred in waters adjacent to the Valdes Peninsula.

Beyond the continental shelf Shoemakers replaced Sooty Shearwaters as the dominant, and usually only, species of shearwater, though they appeared to be no commoner there than in coastal waters. The limited data hint that this species may be more abundant in summer than in winter.

Greater Shearwater (*Puffinus gravis*).— Common to abundant in summer but rare or absent in winter, when the species occurs in the North Atlantic. Our only winter observations were in mid-June 1971: four between 43°40' S and 42°00', and several in Golfo San José. These were apparently late stragglers on the northward migration.

Sooty Shearwater (*Puffinus griseus*).— In winter Sooties are largely restricted to shelf waters north of 45° S; their distribution seems to be strongly affected by surface temperatures for they are rare in waters cooler than 9° C. On the northward transect in June 1971 none were seen south of 43°40' S (9.5° C), but farther north they were common to abundant, particularly near the Valdes Peninsula (maximum, 375/hr.). On the southward transect in July they seemed rarer. Only scattered individuals were seen between the Valdes Peninsula and Golfo San Jorge and the only bird seen farther south (47°35' S) was sick and emaciated (specimen, weight 563 g).

A similar distribution was observed in August 1972, with concentrations off the Valdes Peninsula and the northeastern corner of Golfo San Matías (maximum 800/hr.), and in the mouths of the larger bays. Although some birds occurred as far south as the Strait of Magellan, they were uncommon south of 45° S. One hundred and fifty km off the Valdes Peninsula we observed 600 with large flocks of South American Terns and Magellanic Penguins. Sooties were virtually absent from waters beyond the continental shelf.

Manx Shearwater (*Puffinus puffinus*).— This northern hemisphere migrant winters commonly off the northern coast of Argentina (Cooke and Mills, 1972), but leaves the area in the austral winter. Our only sightings were in 1972; one, 50 km S. of the coast of Uruguay, 27 July; and two in Golfo San Matías, 23 August.

Wilson's Storm-Petrel (*Oceanites oceanicus*).— In both years Wilson's Storm-Petrels were rare over the continental shelf between the Strait of Magellan and Bahía Blanca, and the only area of local abundance (maximum 23/hr) was off the Valdes Peninsula. Nearly all of our observations were made north of 44° S, where surface temperatures exceeded 9° C. The similar distribution patterns found in all three transects indicate that migration is largely completed by June. These petrels were widespread but still uncommon in colder waters (<6° C) beyond the continental slope, Twenty-five, in a small area 225 km SE of Mar del Plata on 29 July 9172, comprised the only significant concentration. Surprisingly, Wilson's Storm-Petrel seems even rarer in shelf waters in summer. Cooke and Mills saw only a single storm-petrel (sp.?) during their transect.

Gray-backed Storm-Petrel (*Garrodia nereis*).— This species was not observed by Cooke and Mills (1971), and Escalante (1970) does not include it in his compilation. We saw only one bird over shelf waters, 37 km offshore at 48°59' S on 15 June 1971. Beyond the shelf, on 30 July 1972, we saw five birds and collected one (♂, wt. 33 g) near 41°38' S, 56°43' W. They were associated with a flock of six Wilson's Storm-Petrels. These appear to represent the northernmost records of the species (cf. Watson et al., 1971; Olrog, 1958), which nests on the Falkland Islands.

Megallanic Diving-Petrel (*Pelecanoides magellani*).— This was the only species of diving-petrel that could be identified in the shelf waters of southern Argentina, and all observations there are referred to it. In each year it occurred to Golfo San Jorge, which is farther north than the range given by Meyer de Schauensee (1966), though it was regular only south of 49° S and common to abundant only between the mouth of the Rio Chico and the Strait of Magellan. The largest concentration (85/hr.) was found in Bahía Grande on 15 July 1971. Although these diving-petrels seem to prefer waters colder than 7° C, we found no seasonal or yearly differences in distribution even though quite different water temperatures prevailed in the two years. In summer Cooke and Mills saw a few diving-petrels, presumably *magellani*, near Bahía Grande.

Subantarctic Diving-Petrel (*Pelecanoides urinatrix*).— This species, which nests on the Falkland Islands, ranges north to Uruguay in winter (Escalante, 1970). Apparently, it follows the Falkland Current, for we saw scattered diving-petrels, all presumably *urinatrix*, well offshore in late July 1972. Our first records were made on the night of 27 July, when 7 flew aboard; all had fed on small crustaceans 8 to 10 mm long. Other sightings were made between 35-42° S, mostly near the edge of the continental shelf; one bird was as close as 160 km from shore. Weights: 2♀: 148, 160 g; 4♂: 120, 144, 145, 145 g.

Great Skua (*Catharacta skua*).— Skuas are rare off Argentina in summer (Cooke and Mills, 1972) and in winter. Our few sightings in 1971 were made within a mile or so of land, generally in the vicinity of bays and harbors, and the only concentration included several flocks on the beach at San Julián on 14 June. Only 9 skuas were seen in 1972: five off Mar del Plata on 27 July, one well offshore on 30 July, and three in near-shore waters between the Valdes Peninsula and Golfo San Jorge. All were referable to *C. s. chilensis* except for one near Mar del Plata which was probably *C. s. antarctica.* In each year several skuas wintered in Golfo San Jose; some of these did not appear to be *chilensis* and may have been *antarctica.*

Parasitic Jaeger (*Stercorarius parasiticus*).— One record, a dark-phased bird near Golfo Nuevo on 18 June 1971.

Kelp Gull (*Larus dominicanus*).— In winter Kelp Gulls disperse widely along the Argentine coast. Apparently their post-breeding movements are largely completed by June, because we noted no important distributional differences in the three transects. Except for local concentrations in bays and near centers of human habitations, this gull was uncommon within 30 km of the coast, and was virtually absent farther offshore. None were seen beyond the continental shelf. Well over 90 per cent of the birds were adults. Cooke and Mills encountered the species rarely, and only near land. Weights: 6♂, 850-1130 (952) g; 8♀, 430 (starved), 680-1040 (865) g.

Brown-hooded Gull (*Larus maculipennis*).— Not seen at sea, except for three in mid-Golfo San Matías in 1971. Fairly common in large harbors north to Buenos Aires.

TABLE 1. Summary of daily censuses, coast of Argentina. June – July 1971. Abundance indicated is number of birds per hour of observation.

	Strait of Magellan to Bahía Blanca									Bahía Blanca to Strait of Magellan					
Species	June 12	13	15	16	17	18	19	21	24	29	30	July 8	13	14	15
Eudyptes crestatus	–	–	–	–	–	–	–	–	–	–	–	–	–	–	0.3
Spheniscus magellanicus	+	–	0.2	0.5	–	7.7	1.5	11.0	13.0	1.7	1.0	14.3	2.0	0.5	1.5
Diomedea exulans/ epomophora	1.5	–	0.4	–	–	0.6	–	0.5	–	–	–	–	0.3	–	3.2
Diomedea melanophris	2.5	1.5	6.8	5.5	1.8	2.7	3.0	1.0	7.0	0.7	0.6	0.3	0.7	3.3	49
Macronectes giganteus	4.0	6.5	7.6	0.5	2.5	6.8	2.5	5.0	3.9	3.3	4.8	1.3	2.0	4.3	18.5
Fulmarus glacialoides	17.5	2.5	2.4	–	–	–	–	–	–	–	–	–	–	–	22.2
Daption capensis	1.5	–	2.0	–	0.2	1.8	0.2	5.0	2.7	–	–	0.7	2.0	2.0	7.5
Pachyptila sp.	1.0	–	2.5	5.2	2.2	0.7	–	–	0.4	–	1.6	–	–	4.7	23.5
Procellaria aequinoctialis	14.5	0.5	3.8	5.0	5.2	6.4	2.2	40	1.7	0.3	0.4	3.3	–	0.8	–
Puffinus griseus	–	–	–	–	–	16.0	66	199	32	–	1.8	43	7.0	0.2	–
Puffinus gravis	–	–	–	–	–	0.1	0.2	1.0	–	–	–	–	–	–	–
Oceanites oceanicus	–	–	0.6	–	0.8	1.8	–	1.5	2.2	–	–	8.3	–	0.2	0.5
Garrodia nereis	–	–	0.2	–	–	–	–	–	–	–	–	–	–	–	–
Pelecanoides sp.	3.5	0.5	3.4	–	1.2	–	–	–	–	–	–	–	–	0.2	0.5
Larus dominicanus	0.5	1.5	0.4	5.0	5.2	2.1	13.5	–	0.4	7.7	0.6	8	0.3	2.2	–
Larus maculipennis	–	–	–	–	–	–	0.5	–	1.3	–	–	–	–	–	–
Sterna hirundinacea	0.5	0.5	0.4	5.0	–	58	100	27	41	9.7	6.4	22.3	4.0	2.5	0.2
Catharacta skua	–	–	–	–	–	–	0.2	–	–	–	–	–	–	–	–
Hours	2	2	5	4	4	7	4	2	2.3	3	5	3	3	4	4
Latitude °S	52 16	49 20	49 02	47 00	45 17	43 22	43 00	42 00	41 34	40 57	42 03	42 01	43 52	47 10	49 52
Longitude °W	68 33	67 34	66 50	65 44	66 42	64 24	65 15	63 42	63 22	62 20	64 05	64 20	65 15	65 27	67 47
Sea Temperature °C	6.5	6.8	7.0	7.8	9.0	9.5	9.5	11.5	11.5	9.1	9.5	10.0	9.1	6.6	4.5

TABLE 2. Summary of daily censuses, coast of Argentina. July – August 1972. Abundance indicated is number of birds per hour of observation. Species seen on fewer than three days are omitted.

	Buenos Aires to Puerto Madryn											Golfo San José tq Bahía Blanca to Strait of Magellan											
Species	July 27A[1]	27P[1]	28A	28P	29A	29P	30A	30P	31A	31P	August 1A	20A	20P	23A	23P	24A	24P	25P	26A	26P	28A	28P	29A
Eudyptes crestatus	—	—	2.8	23.2	10.0	6.2	—	—	—	—	—	—	—	—	—	—	—	—	0.2	0.8	—	—	—
Spheniscus magellanicus	0.2	3.2	0.2	—	—	—	—	—	—	27.2	20.0	1.2	6.7	4.2	19.0	0.2	1:2	5.0	—	1.2	—	0.2	—
Diomedea exulans/ epomophora	—	—	0.8	0.8	8.0	20.0	1.5	3.0	1.5	0.2	—	—	—	0.8	2.4	0.2	—	—	0.2	—	—	+[2]	0.3
Diomedea melanophris	7.7	3.2	5.2	9.4	2500	2625	2.8	1.5	2.8	4.5	3.0	1.0	2.8	4.8	15.0	8.0	3.9	1.8	5.8	27.0	0.3	6.0	2.0
Macronectes giganteus	3.0	2.0	0.2	0.6	75	131	3.0	3.8	3.2	3.6	4.0	2.2	3.5	1.8	3.6	4.2	0.4	3.2	0.7	4.0	2.2	2.0	3.3
Fulmarus glacialoides	—	—	1.0	1.3	0.5	4.0	1.7	4.2	—	—	—	—	—	—	—	2.5	0.6	—	—	0.7	2.3	6.2	2.6
Daption capensis	4.0	13.0	4.8	3.8	1000	1565	3.8	11.2	3.2	10.0	4.0	1.8	0.4	3.5	10.2	3.2	1.7	1.2	2.0	1.5	0.7	0.8	7.8
Pachyptila spp.	—	—	1.2	4.4	—	0.5	6.8	0.2	21.0	0.4	0.2	—	—	4.2	—	—	0.3	0.5	—	—	—	—	3.6
Procellaria aequinoctialis	0.8	19.0	1.2	—	0.8	2.8	0.5	1.0	1.2	7.3	7.0	0.2	1.3	3.8	11.0	4.8	0.3	0.5	1.2	0.8	—	0.5	1.0
Puffinus griseus	5.0	36	1.0	0.4	0.2	—	—	—	3.2	7.2	580	0.8	—	271	53	5.4	38	13.0	0.7	6.5	2.3	6.2	6.0
Oceanites oceanicus	--	0.8	0.2	0.4	0.8	7.0	1.5	0.5	0.5	1.8	—	—	—	1.2	8.8	1.2	—	—	—	—	—	0.2	—
Pelecanoides spp.	—	—	0.2	0.2	—	—	—	—	9.5	0.7	—	—	—	—	—	—	—	—	0.5	—	2.0	1.0	18.0
Larus dominicanus	—	—	—	—	—	—	—	—	—	—	12.0	—	1.2	3.5	5.4	2.7	4.2	7.5	1.0	8.8	9.0	0.2	0.6
Sterna hirundinacea	5.4	29.0	—	—	—	—	—	—	—	270	25.0	5.2	12.0	28.0	60	1.5	21.0	2.8	2.8	9.8	—	—	—
Catharacta skua	—	1.2	—	—	—	—	0.2	—	—	—	—	—	—	0.5	—	0.2	—	—	—	—	—	—	—
Hours	4	4	4	5	4	4	4	4	4	5.5	2	4	4.5	4	5	4	6.5	4	4	4	3	4	3
Latitude °S	35 26	35 26	36 22	38 00	39 22	39 50	41 38	41 42	41 56	42 11	42 50	41 00	41 45	41 37	42 24	43 49	44 24	44 55	47 24	48 00	49 21	49 48	52 19
Longitude °W	55 25	54 21	54 24	55 12	55 22	55 40	56 42	57 33	59 33	61 45	64 20	62 25	62 02	62 11	62 58	65 03	65 10	65 25	65 24	65 35	67 34	67 39	68 15
Sea temperature °C	8.9	10.6	5.6	6.1	5.6	5.6	5.6	5.6	8.9	8.9	8.9	9.5	9.2	9.5	9.5	6.7	6.7	6.7	4.4	3.3	2.2	2.8	2.2

[1] A = A.M. P = P.M.

[2] Recorded, but not in timed census periods

South American Tern (*Sterna hirundinacea*).— After the nesting season South American Terns leave southern Argentina and migrate north to Brazil. They were rare or absent south of 40° S, and uncommon south of Golfo San Jorge. Farther north they were common to abundant, particularly near the mouth of bays and near the Valdes Peninsula, where large flocks were present each year (maximum 375/hr.). We saw no terns beyond the continental shelf, although on 31 July 1972 we observed scattered terns up to 190 km offshore, and 140 km offshore 1500 were feeding with Sooty Shearwaters and Magellanic Penguins. All seemed to be *hirundinacea*, but other species could have been overlooked. Most sighting were made within 30 km of shore.

ZONATION, CONCENTRATIONS

Each of the three oceanographic zones in the survey area contains a distinct faunal assemblage. *Spheniscus magellanicus, Puffinus griseus, Oceanites oceanicus,* and *Sterna hirundinacea* were largely restricted to the continental shelf north of Golfo San Jorge; surface temperatures there were greater than 7° C. Farther south, particularly south of 49° S, sea temperatures were lower and those species were rare or absent. *Fulmarus glacialoides, Eudyptes crestatus, Pelecanoides magellani* appeared and *Diomedea exulans/epomophora* and *Pachyptila* spp. became commoner. In cool waters beyond the continental shelf off northern Argentina the avifauna was similar to that of the southern shelf. Immediately as we passed beyond the shelf *Puffinus griseus, Spheniscus magellanicus*, and *Sterna hirundinacea* dropped out and the following species appeared or occurred in greatly increased numbers: *Diomedea exulans/epomophora, Fulmarus glacialoides, Eudyptes crestatus, Pachyptila* spp., *Garrodia nereis, Procellaria cinereus,* and *Pelecanoides urinatrix*. Note that the diving-petrel of deep waters (*urinatrix*) is not that of the southern shelf (*magellani*).

Precise patterns of distribution within these zones are strongly affected by local conditions, especially turbidity. Waters in many near-shore areas (e.g., the mouth of the Rio de la Plata nearly to Punta del Este; much of the north shore of Golfo San Matías and northward within 15 km of shore to Bahía Blanca; the mouth of the estuary near San Julián) are heavily laden with sediment. This reduces underwater visibility and precludes the presence of divers such as penguins; it also reduces feeding opportunities for plungers such as terns and some shearwaters. Even scavengers are scarce, presumably because increased turbidity also reduces the size of fish populations.

Concentrations of sea birds were found in few localities, and indeed the general sparseness of sea birds over shelf waters was impressive. Concentrations seemed to occur mainly in areas of upwelling or strong tidal currents, where vertical mixing could enrich surface waters. For example, in each year flocks of Magellanic Penguins, Sooty Shearwaters, and South American Terns were at the mouth of Golfo Nuevo and Golfo San José as well as 8-15 km of the northeastern corner of the Valdes Peninsula. On 23 August 1972 large numbers of sea birds were distributed across the mouth of Golfo San Matías, but greatest abundances were realized east of Punta Rasa and near the tip of the Valdes Peninsula. Strong tidal currents prevail in all of these areas. The only other significant concentration over shelf waters consisted largely of great albatrosses, Black-browed Albatrosses, Magellanic Diving-Petrels, Southern Fulmars, and prions in Bahía Grande on 15 July 1971. Surface temperatures there were anamalously cold (4.5° C), suggesting a strong, local upwelling.

Farther offshore, large flocks of terns, penguins, and shearwaters were feeding 150 km east of the Valdes Peninsula on 31 July 1972. Cooke and Mills (1972) also found sea bird concentrations there and pointed out that the area is rich in dissolved nutrients.

The largest concentrations were at the edge of the continental shelf. On the morning of 29 July at 39°22' S, 55°22' W, we estimated 10,000 Black-browed Albatrosses, 30 Royal/Wandering Albatrosses, 4,000 Cape Pigeons, 300 Giant Petrels, 2 Shoemakers, 2 Southern Fulmars, and 1 Sooty Shearwater, all in association with a pod of Pilot Whales. As we passed through the flock we were accompanied by ranks of 50 to 100 Black-brows sailing by in formation, and this sight was repeated in all directions over an area of perhaps eight km^2. Many of the birds, particularly the great albatrosses, were feeding on white wormlike masses approximately 20 cm long, and on dead reddish fish (presumably *Sebastes* or *Helicolenus*, Scorpaenidae). That afternoon we found an even larger concentration, also at the edge of the shelf, near 39°40' S, 55°35' W. There, 10,000-12,000 Black-browed Albatrosses, 50 Royal/Wandering Albatrosses, 6,000 Cape Pigeons, and 500 Giant Petrels were feeding on offal from a large trawler. In each area sonar tracings revealed the presence of large schools of fish.

SEASONAL DIFFERENCES

Census data indicate few pronounced differences in the distribution and abundance of most species over the Argentine coastal shelf in winter. Apparently wintering populations are established by mid-June and remain largely stable through August. To obtain a more representative picture of average winter conditions, I pooled the data from all three transects. This procedure reduces bias from inadequate sampling on individual transects and minimizes differences caused by minor variations in routes. In Table 3 the combined data are compared with those gathered by Cooke and Mills in a rapid transect between Buenos Aires and Tierra del Fuego in summer. For convenience the data are grouped by 2° increments of latitude. The data from each season are not so complete as to inspire any great confidence as to their general applicability; however, they are the only available quantitative data and can be used to make preliminary comparisons of summer and winter patterns.

Differences between the summer and winter surveys are largely interpretable in terms of the breeding biology of particular species. For example, the high density of *Speniscus magellanicus* south of 44° S in summer is attributable to concentrations in the vicinity of nesting colonies; winter densities are lower because the species disperses widely over the northern shelf waters. A similar pattern of increased density near known or presumed southern nesting grounds in summer followed by northward dispersal in winter is shown by *Pachyptila* ssp. (presumably *P. belcheri* from the Falkland Islands), *Eudyptes crestatus*, and *Pelecanoides magellani*.

Albatrosses and Giant Petrels occupy the shelf waters year-round, with few differences in distribution or abundance. These species have long deferred maturity. If populations of great albatrosses in the area consist largely of pre-breeding-age individuals, as seems to be the case for *D. epomophora*, the lack of large seasonal differences would not be unexpected. However, the higher density of *Macronectes* in winter may reflect a post-nesting influx of adults. This is suggested by the apparent increase in adults in August 1972 as compared with earlier censuses. Large concentrations of *Diomedea melanophris* between 42-48° S in summer suggest locally rich feeding conditions that do not persist into the winter months.

Though not as pronounced, deferred maturity is also characteristic of smaller Procellariiformes (Ashmole, 1971: Table 2), and one would expect some non-breeders of most species to occur in the area throughout the year. The absence of fulmarine petrels (*Fulmarus glacialoides, Daption capensis*) in summer is probably attributable to their breeding biology: young birds tend to search for nesting sites at colonies several years in advance of active breeding (G. E. Watson, pers, comm.).

Procellaria aequinoctialis is resident in the southern hemisphere, nesting in the austral summer (Murphy, 1936: 644;. Its apparent predominance in summer seems unusual and may be due to concentrations of non-breeders near 44° S; the situation may be similar to that shown by *D. melanophris*. *Puffinus gravis* was virtually absent in winter, having migrated to the northern hemisphere; its abundance far from any known nesting grounds in summer presumably indicates a large population of non-breeding individuals (see also Watson, 1971; Tickell and Woods, 1972). Most *Puffinus griseus* winter in the northern hemisphere, but large numbers occur over the Argentine shelf all year. The limited data do not suggest any important differences in abundance between wintering and summering populations in the area, but there is an obvious shift northward in winter. However, much greater abundances are expected during periods of migration.

TABLE 3. A comparison of winter (W) and summer (S) seabird densities over the continental shelf of Argentina. Winter data are pooled from three transects (see text); summer data are from one transect (Cooke and Mills, 1972). Abundance indicated is number of birds per hour of observation. Species seen on fewer than five days are omitted from the winter sample.

		Latitude °S						
Species		40-42	42-44	44-46	46-48	48-50	50-52	52-54
Eudyptes crestatus	W	—	—	—	0.5	—	0.4	—
	S		—	—	—	—	—	0.5
Spheniscus magellanicus	W	5.4	5.4	1.7	0.5	0.5	0.8	—
	S		—	19.5	10.0	3.0	0.8	0.5
Diomedea exulans/ epomophora	W	0.3	0.6	—	0.1	0.1	6.0	0.4
	S		0.5	0.7	1.7	0.3	0.8	—
Diomedea melanophris	W	3.0	5.3	2.9	10.8	9.7	66	2.4
	S		9.2	32	13.2	5.5	0.8	3.5
Macronectes giganteus	W	2.8	3.1	3.6	2.8	6.8	8.0	3.1
	S		2.7	2.2	3.1	2.1	1.6	1.0
Fulmarus glacialoides	W	—	0.3	0.2	0.5	7.5	41	6.0
	S		—	—	—	—	—	—
Daption capensis	W	2.0	2.6	1.4	1.6	1.3	13.2	5.4
	S		—	—	—	—	—	—
Pachyptila spp.	W	2.5	2.5	0.8	2.1	8.0	78	4.4
	S		—	—	—	—	16.3	19.0
Procellaria aequinoctialis	W	2.1	7.5	0.8	2.1	0.7	6.8	5.6
	S		15.1	60	4.8	1.5	0.8	0.5
Puffinus gravis	W	—	—	—	—	—	—	—
	S		36	284	67	8.3	0.8	0.5
Puffinus griseus	W	120	36	18.0	1.7	2.4	—	3.6
	S		5.6	51	0.8	—	—	1.0
Puffinus puffinus	W	—	—	—	—	—	—	—
	S		—	—	—	4.4	—	—
Oceanites oceanicus (incl. petrel sp.)	W	1.1	2.5	0.5	0.2	0.2	—	—
	S		0.5	—	—	—	—	—
Pelecanoides magellani (and Pelecanoides sp.)	W	—	—	0.4	0.9	1.9	0.8	11.8
	S		—	—	—	—	27.6	2.5
Catharacta skua	W	0.5	0.1	0.2	—	—	—	—
	S		0.4	—	—	0.9	—	—
Stercorarius parasiticus (and Stercorarius sp.)	W	—	—	—	—	—	—	—
	S		0.6	0.7	3.5	40	0.8	—
Larus dominicanus	W	2.2	4.3	6.6	3.9	2.4	0.4	0.4
	S		—	—	—	—	—	0.5
Sterna hirundinacea	W	24.8	39.6	9.2	4.8	0.2	0.4	—
	S		—	—	—	—	—	2.0
Hours of observation	W	9.3	31.0	16.5	17.0	13.5	2.5	5.0
	S		6.2	2.7	2.3	3.2	1.2	2.0

Oceanites oceanicus and *Catharacta skua* were uncommon at both seasons, though more widespread and northerly in winter. Post-breeding northward dispersal in *Larus dominicanus* and *Sterna hirundinacea* is largely responsible for their predominance in the winter censuses, although the virtual absence of *L. dominicanus* in summer is partly attributable to the fact that Cooke and Mills' route was farther offshore than the normal range of this gull.

Two migrants from the northern hemisphere, *Puffinus puffinus* and *Stercorarius parasiticus*, occurred almost exclusively in their non-breeding season, the austral summer; at the latitudes under consideration the shearwater is very uncommon.

In all three winter transects the transition between the northern and southern shelf avifaunas occurred near 47° S. Cooke and Mills suggested that the transition zone was nearer 50°S in summer, but it seems to occur near Golfo San Jorge area in that season as well (Table 3, Fig. 5).

ECOLOGICAL CONSIDERATIONS

Despite their limitations, the quantitative data are useful in suggesting questions for future research. For example, do latitudinal or seasonal distributional patterns of sea birds suggest corresponding differences in the productivity of shelf waters. Neither the winter nor the summer data show any consistent relationship between latitude and sea bird abundance (Fig. 3), although in both seasons the highest concentrations were recorded in the northern half of the census area. Seasonal differences in abundance also seem minor, as the summer and winter curves correspond fairly closely over most of the range. (North of 40° S the winter data were largely gathered beyond the continental shelf.) Biomass is a more useful index to productivity, for it indicates the total mass of

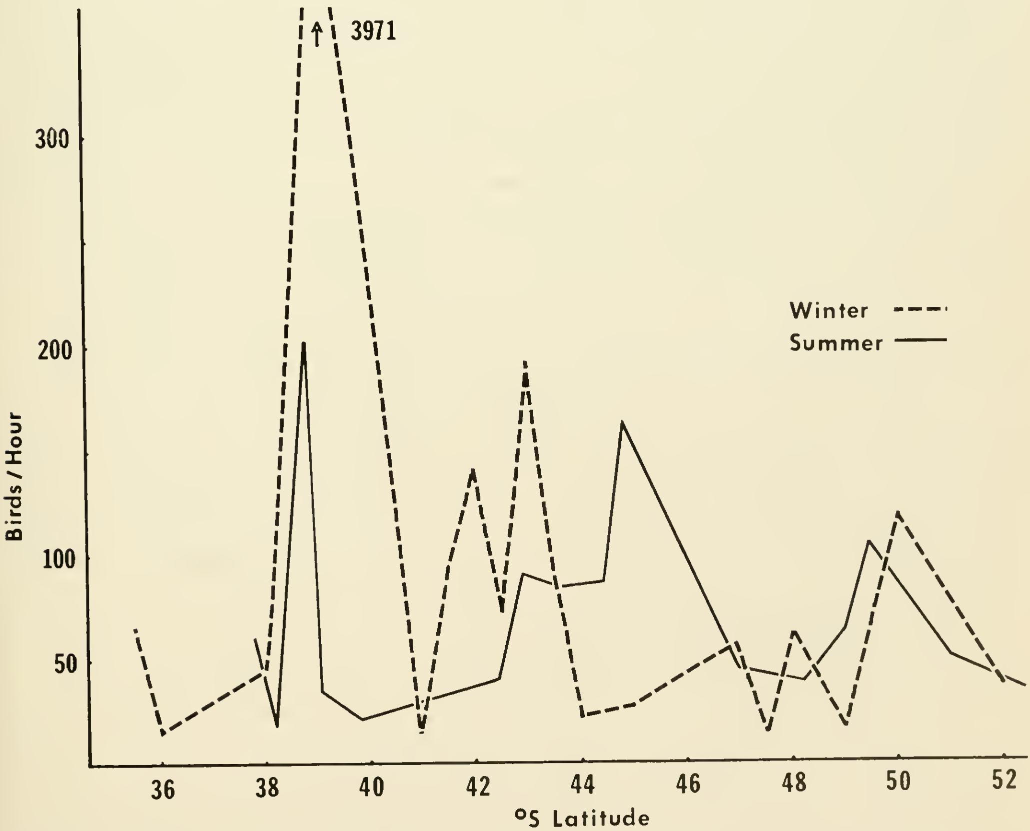

Figure 3. Sea bird abundance along the coast of Argentina, plotted to nearest 0° 30' of latitude. Winter data are pooled from three transects; summer data are from Cooke and Mills (1972).

organisms that is being maintained in an area. To obtain this statistic, the density of each species in Table 3 was multiplied by its average weight (Appendix) and the results were summed, giving grams/hours/2° increment of latitude. The data hint at increased biomass to the north (Fig. 4), but they are strongly biased by inadequate sampling, particularly at the higher latitudes. The winter peak at 50-52° S is especially suspect, being based on only 2-1/2 hours of observations on a single day. In summary, present data on sea bird abundance and biomass do not indicate marked seasonal or latitudinal differences in the productivity of the Argentine coastal waters. This conclusion is tentative and requires additional study.

A more interesting question is how seasonal and latitudinal differences in species composition may affect patterns of resource utilization. Table 4 presents a simplified ecological classification of sea birds modified after Ashmole (1971), which should be consulted for details. In this table, I have grouped the avifauna into nine categories based on size of bird, major feeding behaviors, and food preferences. The Shoemaker is separated from the other shearwaters partly because of its greater size and different feeding behavior, but mainly because it is resident in the southern hemisphere and therefore its ecological impact is expected to be more constant. Since total biomass at any latitude is variable (Fig. 4) and is strongly affected by census errors, the data have been converted to a percentage basis for each category. When these data are presented graphically (Fig. 5) the marked change in the ecological composition of the sea bird community at 46-48° S is emphasized.

In summer, north of this area, virtually the entire biomass is made up of large species that obtain their food from the upper meter of the sea, mainly by surface seizing or pursuit plunging (albatrosses, large and small shearwaters). The remainder consists largely of divers (penguins) that feed on fish. Groups that feed at least in part by filtering small organisms (fulmarine petrels, prions and storm-petrels) are absent. South of 46-48° S large surface feeders compose only 50-60 per cent of the biomass, and there is a sharp increase in the biomass of divers and filter feeders. The high percentage of gulls and skuas at 48-50° S is based on a concentration of Parasitic Jaegers. Jaegers typically derive much of their food by piracy; however, since likely prey species were rare or absent they may have been feeding by surface seizing or scavenging.

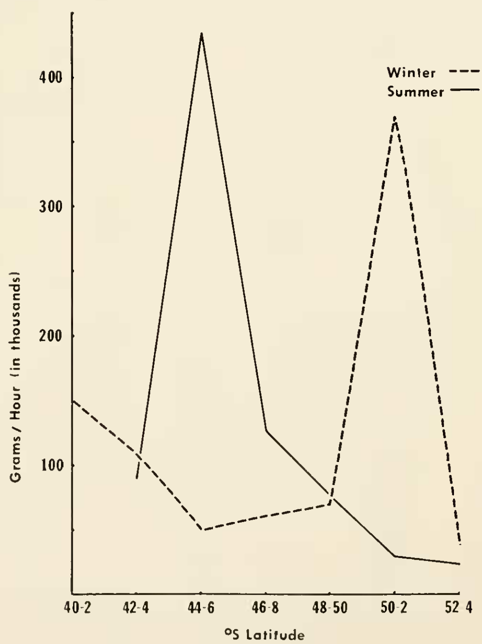

Figure 4. Seasonal relationship between biomass (grams/hour) and latitude along the coast of Argentina, plotted by 2° increments of latitude. Winter data are pooled from three transects, summer data are from Cooke and Mills (1972).

TABLE 4. A simplified ecological classification of seabirds (modified from Ashmole, 1971).

Group	Species	Weight	Major Food	Foraging Behavior
A. Albatrosses and giant petrels	Diomedea exulans D. epomophora D. melanophris Macronectes giganteus	Larger than 3000g	Fish, carrion, cephalopods	Surface seizing, scavenging
B. Fulmarine petrels	Fulmarus glacialoides Daption capensis	350-700g	Crustaceans, cephalopods, carrion	Surface seizing, filtering, scavenging
C. Gulls and skuas	Larus dominicanus Catharacta skua Stercorarius parasiticus	500-1500g	Varied	Scavenging, surface seizing, piracy
D. Prions and storm-petrels	Pachyptila spp. Oceanites oceanicus Garrodia nereis	30-130g	Small fish, plankton	Filtering, pattering
E. Large shearwaters	Procellaria aequinoctialis	1250g	Cephalopods, fish, crustaceans	Surface seizing, pursuit plunging
F. Smaller shearwaters	Puffinus gravis Puffinus griseus Puffinus puffinus	400-750g	Fish, cephalopods crustaceans	Surface seizing, pursuit plunging
G. Terns	Sterna hirundinacea	200g	Small fish	Plunging
H. Penguins	Spheniscus magellanicus Eudyptes crestatus	2500-4900g	Fish, cephalopods, crustaceans	Pursuit diving
I. Diving-petrels	Pelecanoides magellani Pelecanoides urinatrix	150-160g	Crustaceans, small fish	Pursuit diving

In winter the transition zone persists at 46-48° S, but biomass relationships are more complex. The proportion of surface feeders increases from about 75 per cent in the north to 90 per cent in the south. In the north this is divided among albatrosses, large and small shearwaters, and gulls; the remainder consists of diver (penguins) and plungers (terns). In the south albatrosses alone make up approximately 75 per cent of the biomass, the remainder being contributed by smaller surface feeders and filter feeders; the percentage of divers is much reduced, and plungers are absent.

Through the year the biomass contributed by some ecological groups remains fairly constant. Surface feeders dominate the shelf waters all year, and piratical feeders make up a fairly consistent though small proportion of the biomass. It is interesting, however, that major seasonal shifts in distribution shown by many species are not accompanied by a compensatory movement into the vacated area by taxa that utilize the similar foods. For example, penguins vacate the southern shelf in winter, and fulmarine petrels, prions, and diving-petrels shift northward. The biomass they contributed to southern waters is not replaced by other divers, small scavengers, or filter feeders but by large surface feeders. Also, terns congregate over the northern shelf in winter, an area that contained no plungers in summer. These shifts may indicate an increase in the spectrum of available food in winter. More likely, however, a wide variety of foods is present all year but cannot be exploited in summer because this area is too distant from nesting colonies.

Marine bird populations beyond the continental shelf.— The marine avifauna beyond the continental shelf differs importantly both in species composition and in relative abundance of species from that nearer shore. The major differences noted in winter have been discussed (p. 226). Tickell and Woods (1972) reported several species on transects between Montevideo, Uruguay, and the Falkland Islands from late spring to late autumn that we did not find over the shelf in winter. These included *Phoebetria palpebrata*, *Pterodroma macroptera*, *Pt. lessoni*, *Pt. incerta*, *Pt. mollis*, *Halobaena caerulea*, *Fregetta tropica*, *Fregetta grallaria*, *Stercorarius pomarinus*, and *S.*

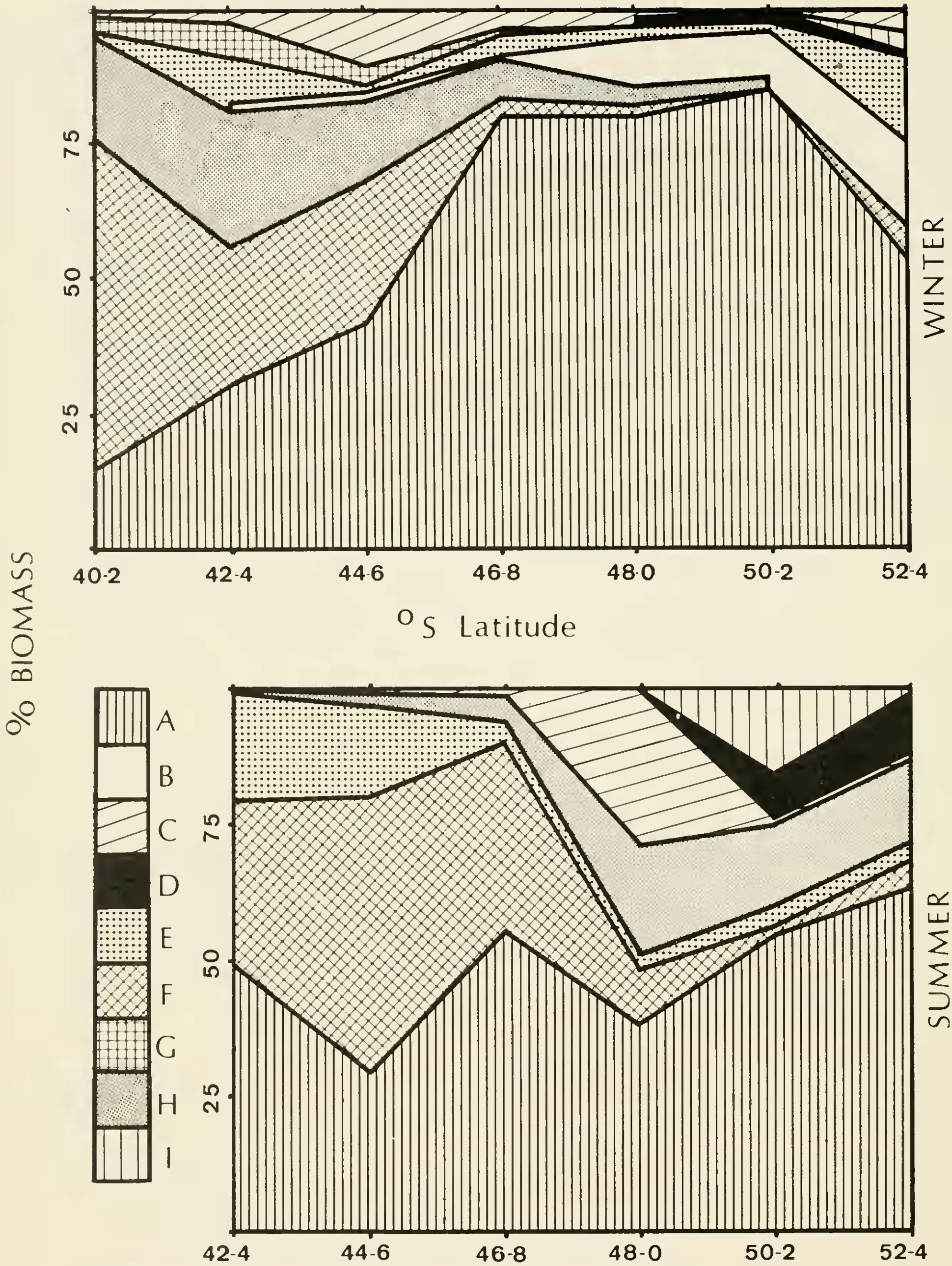

Figure 5. Biomass relationships of seabirds by feeding types, along the coast of Argentina in winter (upper) and summer (lower). Groupings comprising less than 1 per cent of the biomass for any period are not plotted. A. Albatrosses and giant petrels. B. Fulmarine petrels. C. Gulls and skuas. D. Prions and storm-petrels. E. Large shearwaters. F. Smaller shearwaters. G. Terns. H. Penguins. I. Diving-petrels.

longicaudus. Several other species e.g., (*Procellaria cinereus, Puffinus gravis, Garrodia nereis*) seemed to be far commoner in deep waters than near shore. Almost certainly, sea bird density, latitudinal patterns of abundance and distribution, and ecological patterns of resource utilization also differ significantly between these areas, but the only semi-quantitative data (Tickell and Woods, 1972) are insufficient to permit even preliminary comparison and analysis.

MORTALITY

In 1972 we found the desiccated remains of Magellanic Penguins every 30 m or so along the beaches of Golfo San José (Jehl et al., 1973); extensive mortality was also noted at Punta Norte and elsewhere on the Valdes Peninsula. Most of the birds had been dead for a long time, and although there was no evidence that the mortality had been caused by a single event, the majority of the carcasses were oiled. At sea it was not uncommon to observe oiled albatrosses, Giant Petrels, and Cape Pigeons. I made no quantitative estimates, but the incidence of oiling was greatest off northern Argentina, particularly in the vicinity of the Rio de la Plata. This heavily-trafficked area is close to one of the most important feeding grounds for sea birds in the South Atlantic (Murphy, 1936; Robertson and Kinsky, 1962; Cooke and Mills, 1972). In many miles of beachcombing in Golfo San José, I found the remains of few pelagic birds other than penguins, and none that were oiled. Flying birds are less likely than penguins to amass lethal doses of oil at one sitting, but even small amounts can break down the insulation of the feather coat and lead to death far from the area of contamination. Further, the pelts of Procellariiformes are less durable than the tough hides of penguins, and their bodies seem more likely to be devoured by Giant Petrels and other scavengers before they can drift ashore. I suspect that the incidence of sea bird mortality from oil pollution, even in the remote reaches of the South Atlantic, is more insidious and pervasive than the present documentary evidence indicates (see also Jehl, 1975).

ACKNOWLEDGMENTS

The research was made possible from a grant (NSF-GV-32739) from the National Science Foundation. The assistance and cooperation of Master Frank Liberty, Master P. J. Lenie, and the crew of the R/V Hero is sincerely appreciated. I am indebted to Jon P. Winter, W. C. Cummings, J. F. Fish, and P. O. Thompson for assistance in the field, to Carl L. Hubbs for ichthyological information, and to George E. Watson for commenting on a draft of the manuscript.

LITERATURE CITED

Alexander, W. B., et al.
1965. The families and genera of the petrels and their names. Ibis 107: 401-405.

Aragno, F. J.
1968. Datos y resultados preliminares de las campañas pesqueria: "Pesqueria I, II, III." Mar del Plata, Argentina, Publicaciones del projecto de desarrollo pesquero (Series Informes Téchnicos) Nos. 10/I, 10/II, 10/III.

Ashmole, N. P.
1971. Sea bird ecology and the marine environment, p. 223-286. *In*, D. S. Farner and J. R. King (eds.), Avian Biology, Vol. 1. Academic Press, N. Y. and London.

Bourne, W. R. P., and J. Warham
1966. Geographical variation in the Giant Petrels of the genus *Macronectes*. Ardea 54: 45-67.

Cooke, F., and E. L. Mills
1972. Summer distribution of pelagic birds off the coast of Argentina. Ibis 144: 245-251.

Cummings, W. C., J. R. Fish, P. O. Thompson, and J. R. Jehl, Jr.
1971. Bioacoustics of marine mammals off Argentina, R. V. Hero, Cruise 71-3. Antarctic J. U. S. 6(6): 266-268.

Escalante, R.
1970. Aves marinas del Rio de la Plata. Montevideo, Barreiro y Ramos, S. A.

Jehl, J. R., Jr.
1973a. The distribution of marine birds in Chilean waters in winter. Auk 90: 114-135.
1973b. Winter populations of marine birds along the coast of Argentina. Antarctic J. U. S., 7(2): 32-33.
1975. Mortality of Magellanic Penguins in Argentina. Auk 92, in press.

Jehl, J. R., Jr., M. A. E. Rumboll, and J. P. Winter
1973. Winter bird populations in Golfo San José, Argentina. Bull. Brit. Ornith. Cl. 93: 56-63.

King, W. B.
1970. The trade wind zone oceanography pilot study. Part 7: Observations of sea birds March 1964 to June 1965. U. S. Fish Wildl. Serv. Spec. Sci. Rept. Fish. No. 586.

Lack, D.
1968. Ecological adaptations for breeding in birds. London, Methuen and Co., Ltd.

Meyer de Schauensee, R.
1966. The species of birds of South America. Narberth, Pennsylvania, Livingston Publ. Co.

Murphy, R. C.
1936. Oceanic birds of South America, 2 vols. New York, Amer. Mus. Nat. Hist.
Olrog, C. C.
1958. Observaciones sobre la avifauna antarctica y de alta mar desde el Rio de la Plata hasta 60° de latitud sur. Acta Zool. Lilloana, 15: 19-33.
Robertson, C. J. R., and F. C. Kinsky
1972. The dispersal movements of the Royal Albatross (*Diomedea epomophora*). Notornis, 19: 289-301.
Serventy, D. L., V. Serventy, and J. Warham
1971. The handbook of Australian Sea-birds. Sydney, A. H. and A. W. Reed.
Tickell, W. L. N.
1968. The biology of the great albatrosses, *Diomedea exulans* and *Diomedea epomophora*, p. 1-55. *In*, O. L. Austin, Jr. (ed.), Antarctic bird studies. Antarctic Res. Ser. 12. 262 p. Washington, D.C., American Geophysical Union.
Tickell, W. L. N., and R. W. Woods
1972. Ornithological observations at sea in the South Atlantic Ocean, 1954-64. Brit. Antarct. Surv. Bull. 31: 63-84.
Valdes, A. J.
1969. Datos y resultados de las campañas pesqueria: "Pesqueria V." Mar del Plata, Argentina, Publicaciones del projecto de desarrollo pesquero (Serie Informes Téchnicos), No. 10/V.
Villanueva, S. D. (ed.)
1969-71. Datos y resultados de las campañas pesqueria: "Pesqueria VI, VII, VIII, IX, X, XI." Mar del Plata, Argentina. Publicaciones del projecto de desarrollo pesquero (Serie Informes Téchnicos; Nos. 10/VI, 10/VII, 10/VIII, 10/IX, 10/X, 10/XI.
Watson, G. E.
1971. Molting Greater Shearwaters (*Puffinus gravis*) off Tierra del Fuego. Auk 88: 440-442.
Watson, G. E., et al.
1971. Birds of the Antarctic and Subantarctic. Antarctic Map Folio Ser. Folio 14, New York, Amer. Geogr. Soc.

San Diego Natural History Museum, P.O. Box 1390, San Diego, California, 92112.

APPENDIX I
Weights of seabirds[1]

Eudyptes crestatus, 2500 (L). *Spheniscus magellanicus*, 4900 (L). *Diomedea exulans/epomophora*, 8500 (L, SSW, SD). *Diomedea melanophris*, 3600 (SD). *Macronectes giganteus*, 3000 (SSW, SD). *Fulmarus glacialoides*, 700 (J). *Daption capensis*, 350 (J). *Pachyptila* spp., 130 (J). *Procellaria aequinoctialis*, 1250 (SD). *Puffinus griseus*, 750 (J). *Puffinus gravis*, 650 (E). *Puffinus puffinus*, 400 (L). *Oceanites oceanicus*, 30 (L, J). *Pelecanoides magellani*, 160 (J). *Pelecanoides urinatrix*, 150 (SD, this paper). *Catharacta skua*, 1400 (SD). *Stercorarius parasiticus*, 500 (L). *Larus dominicanus*, 910 (SD). *Sterna hirundinacea*, 200 (SD).

---

[1]References: L = Lack, 1968, appendix 17. J = Jehl, 1973a. SSW = Serventy, Serventy, and Warham, 1971. SD = specimens in San Diego Natural History Museum. E = estimate.